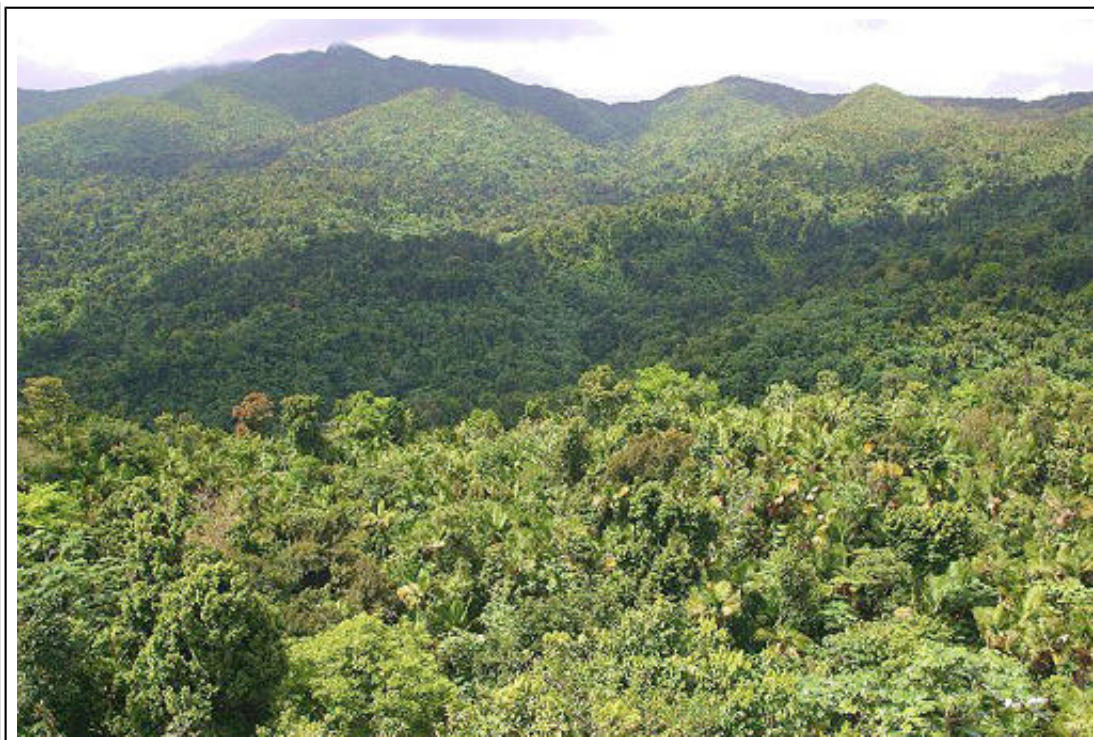




El Yunque Caribbean National Forest

INTRODUCTION





Courtesy of Father Alejandro Sánchez

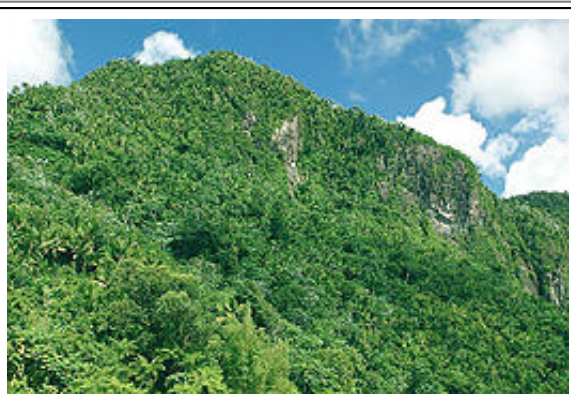
The canopy of trees in El Yunque forms a green carpet that covers the mountains, Sierra de Luquillo.

The island of Puerto Rico is a self-governing commonwealth under the jurisdiction of the United States. It is in the Caribbean Sea, 1,600 km (1,000 miles) southeast of Florida. On the eastern tip of Puerto Rico, 40 kilometers (24.8 miles) from the capital of San Juan, is the Caribbean National Forest, commonly called El Yunque (e•YOONG•kay). It is the only tropical [rain forest](#) in the U.S. National Forest System. El Yunque Peak rises 1065 meters (3494 feet) among the rugged, isolated mountains of Sierra de Luquillo. El Yunque gets its name from the cloud-shrouded mountain tops. The native Tiano people called these mountain tops "yuke," meaning "white lands."



Courtesy of NASA

The island of Puerto Rico is in the Caribbean Sea, southeast of Florida. Cloud cover marks the location of El Yunque.



Courtesy of Father Alejandro Sánchez

Dense forests were cut for shipbuilding in the 19th century.

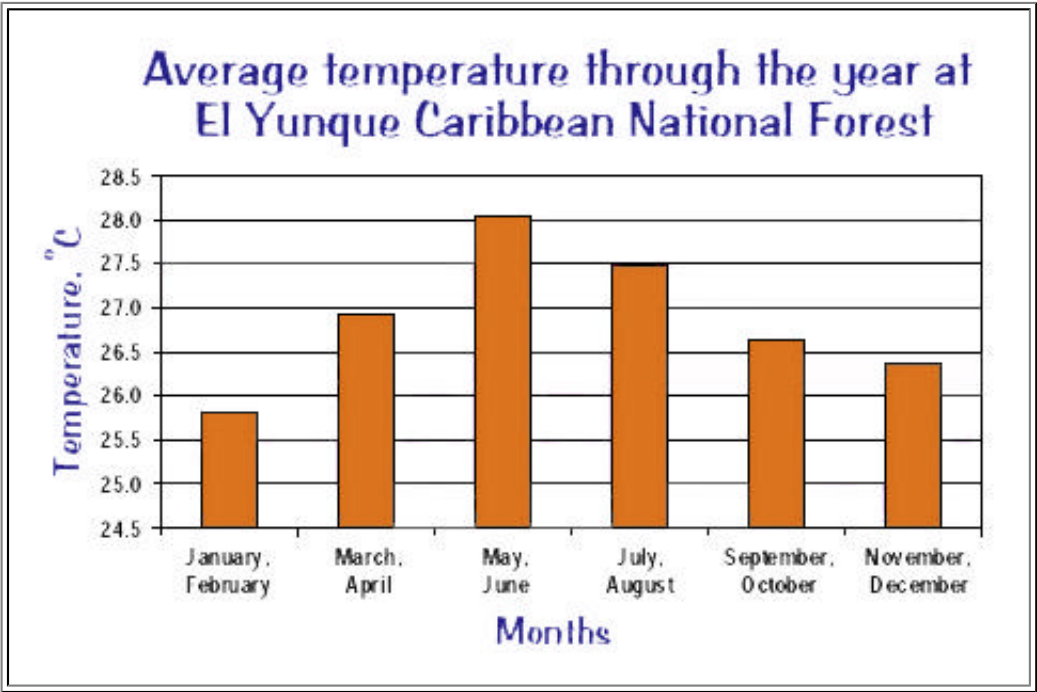
El Yunque covers approximately 11,300 hectares (28,000 acres) of diverse vegetation. The forest was originally established in 1876 when Puerto Rico was still under Spanish rule. King Alfonso XII of Spain proclaimed El Yunque a forest reserve. It became one of the first reserves in the Western Hemisphere. He declared this reserve, not to

preserve the diversity and beauty of El Yunque, but because the forests were filled with trees that were used to build ships. By declaring it a reserve, the lumber was protected from enemies that might make ships to fight the Spanish. This land passed to the United States in 1898, and was renamed the Luquillo Forest Reserve in 1903.

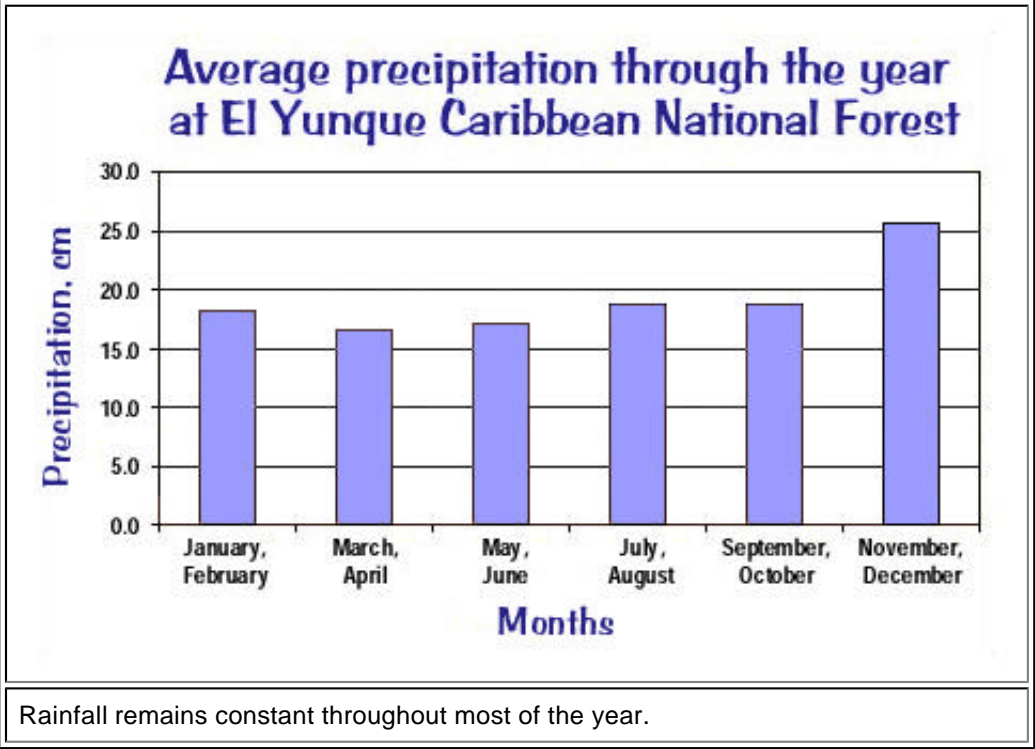
ABIOTIC DATA

Because Puerto Rico is south of the Tropic of Cancer, it has a tropical climate. There is no distinct wet or dry season at El Yunque; it rains year-round. The temperature and length of daylight remain fairly constant throughout the year. All these factors provide a year-round growing season.

The elevations at El Yunque vary from about 100 to 1000 meters (300 to 3500 feet). The highest point is Pico del Toro, 1080 meters (3542 feet). Mountain slopes are very steep, often angling up at more than 45°. Temperatures do not vary much through the year. The temperature is warm, and ranges from 25.5 to 28°C (78 to 82°F) at lower elevations to highs of only 17.5°C (63.5°F) in the mountains.



It rains daily at El Yunque, with slightly more rain in the winter. Average precipitation is 510 centimeters (200 inches) per year. The amount of rainfall in Puerto Rico varies in relationship to El Yunque Peak. The peak creates a rain shadow. Trade winds bring heavy rainfall to El Yunque Peak and the rain forest, while San Juan, to the east, receives only 150 centimeters (60 inches) per year. On the south coast, Ponce receives only 91 centimeters (36 inches) per year.



Day length does not vary much in the tropics. There are 11 to 13.25 hours of light each day throughout the year.

The soil at El Yunque contains a lot of clay (45–75%). As in most tropical forests, most soil nutrients are in the top 10 centimeters (4 inches). Nutrients are quickly washed away from soil by heavy rains.

Tropical storms and hurricanes frequently pass over Puerto Rico and El Yunque. Both Hurricane Hugo in 1990 and Hurricane Georges in 1998 damaged the forest. Hurricane Georges was especially damaging, with winds over 185 kilometers per hour (115 miles per hour), which knocked down trees and ruined buildings. This hurricane caused over \$5 million in damage to El Yunque. Hurricane season in the Caribbean lasts from June to November.


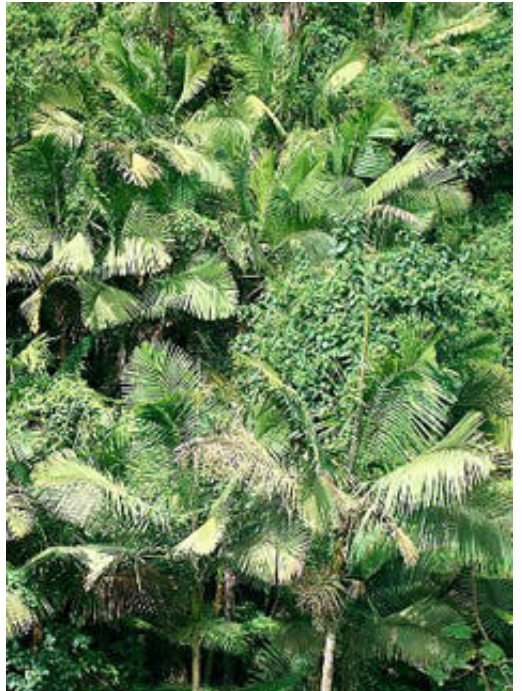


Courtesy of Father Alejandro Sánchez

This opening in the canopy is the result of Hurricane Georges in 1998. In a few years the surrounding palms will close the gap.

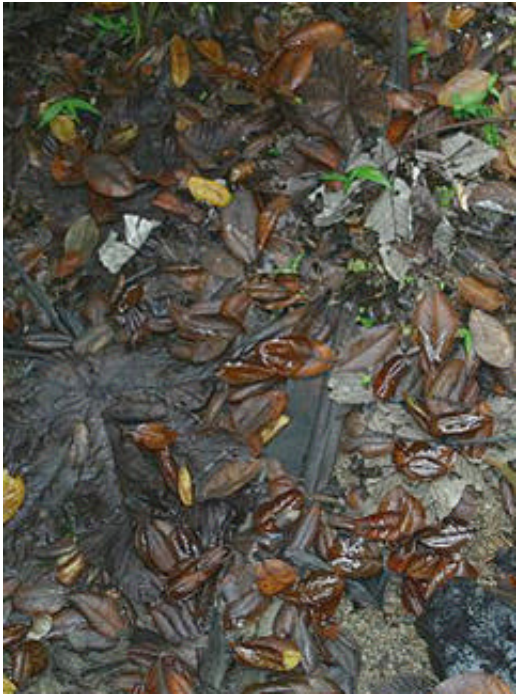

BIOTIC DATA

El Yunque has four kinds of tropical forest: subtropical rain forest above 600 meters (1968 feet), cloud forest high in the mountains, high wet forest between these two, and lowland wet forest at the lower elevations. The subtropical rain forest is dominated by [sierran palms](#) and [pumpwood trees](#); the cloud forest is dominated by dwarf trees.

	
Courtesy ofFather Alejandro Sánchez	Courtesy ofFather Alejandro Sánchez
Pumpwood trees have a characteristic umbrella shape.	Sierran palms form the forest canopy.


In a tropical forest are four distinct layers, the forest floor, the understory, the canopy, and the emergent layer.

The forest floor is covered with leaf litter, detritus, [mushrooms](#), [isopods](#), and insects. Leaves that fall on the forest floor may decompose in a few weeks rather than years. Nutrients are quickly absorbed by nearby plants or washed away by frequent rains.

	
Courtesyof Father Alejandro Sánchez	Courtesyof Father Alejandro Sánchez
Damp leaf litter decomposes quickly.	Damp conditions encourage algal growth on everything, including this <i>Caracolus</i> snail. Two smaller <i>Nenia</i> snails are grazing on the algae.

Next is the understory, a mass of vines, dwarf trees, and plants that can survive in low light with very little air circulation. Plants rely on insects for pollination and produce large, sweet-smelling, and colorful flowers to attract pollinators. Many of the animals that pollinate these plants live their entire lives in the understory. [Ants](#), [twig dwarf anoles](#), [geckos](#), [walkingsticks](#), and [giant crab spiders](#) live in the understory.


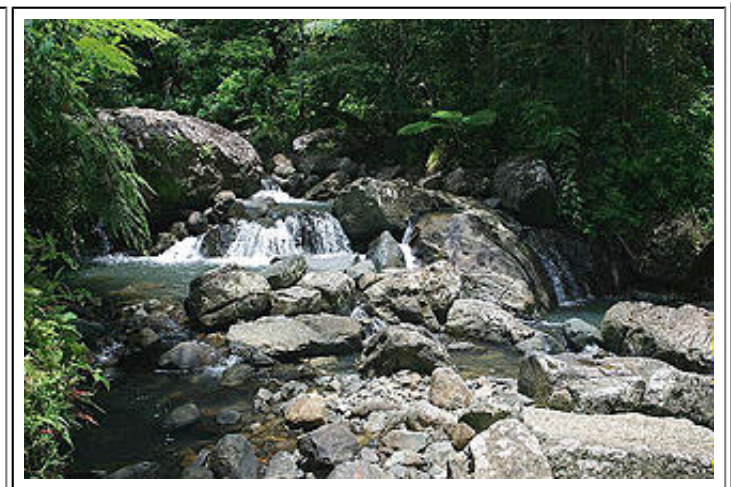
The larger trees make up the rain-forest canopy. These trees typically have large, deep-green leaves near the tops, like [sierran palms](#) and [pumpwood trees](#). The dark leaves absorb most of the sunlight; only about 5% filters through to the understory. Rain and moisture that falls on the leaves drop to the forest floor. Epiphytes, like [orchids](#) and bromeliads, are plants that grow on other plants without ever touching the ground. They grow high in canopy trees to capture sunlight and obtain water and minerals from rainfall. [Red-tailed hawks](#) make their nests in the tall canopy trees, but feed on the abundant life of the understory. Endangered Puerto Rican parrots live in cavities of larger trees. The familiar "kooooo-keee" call of the [coqui frog](#) can be heard throughout the canopy, understory, and forest floor. The coqui frog is a favorite among Puerto Ricans and is their unofficial national mascot. The populations of the Puerto Rican parrot and coqui frog have drastically decreased in Puerto Rico since the 1500s.

	
Courtesy ofFather Alejandro Sánchez	Courtesy ofFather Alejandro Sánchez
Coqui frogs climb up into trees at night, looking for food and mates. They jump back to the forest floor rather than climb down.	Centipedes forage for prey on the forest floor.

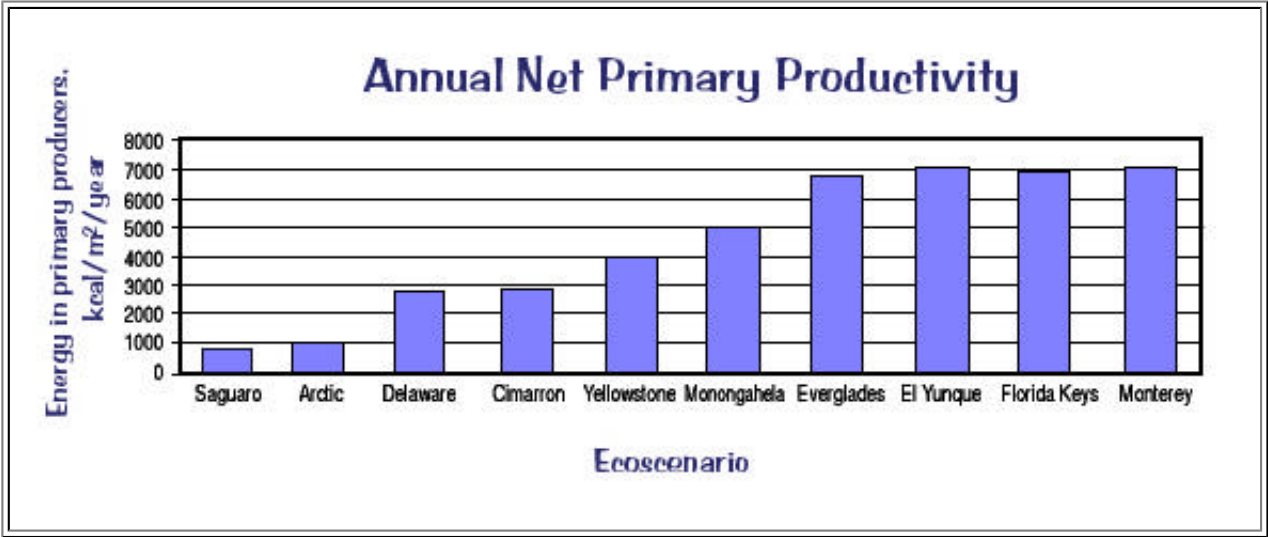
The tallest trees make up the emergent layer, which rises above the dense canopy of shorter trees. These trees take advantage of increased air circulation and rely on wind pollination and winged seeds for seed dispersal. Thick, waxy leaves reduce the amount of water released through transpiration in the hot tropical sun.

Each layer of the rain forest is characterized by a community of organisms and distinct food webs. Some animal populations do not move beyond the layer they live in. There are more than 200 species of birds found in Puerto Rico and many more species of insects and invertebrates.

Invertebrates are especially diverse and numerous at El Yunque. [Ants](#), [beetles](#), [butterflies](#), [termites](#), [spiders](#), and many other types of invertebrates are found in every forest layer. The climate is warm and moist enough for reptiles and amphibians such as the [coqui frog](#), [anoles](#), and [geckos](#). Historical records show 22 kinds of mammals in Puerto Rico. While many still live in Puerto Rico today, such as the [Jamaican fruit bat](#), many of the native species have disappeared, and nonnative mammals, such as rats and mongooses, are there instead. The larger predators include [red-tailed hawks](#), [tarantulas](#), and [centipedes](#).

	
Courtesy ofGerardo R. Camilo	Courtesy ofFather Alejandro Sánchez
Red-tailed hawk and chick in a nest high in the canopy	The densest vegetation grows along streams.

Plant and animal life at El Yunque is diverse, as you would expect for a tropical forest. However, El Yunque has fewer species than a mainland tropical forest, such as those in Central and South America. Islands have a smaller land area for organisms to use than mainlands do, and island populations are isolated from populations on the mainland. Over time these small populations have adapted to their unique environment. When populations of plants or animals are small, there is a greater chance that they will become extinct if too much pressure is placed on the population.



Annual productivity, or the amount of energy provided by the producers in this ecosystem, is very high, 6750 kilocalories/square meter/year. Because there is not much variation in day length, temperature, or precipitation, there are no seasons here. Plants can grow and flower year-round. Migrating birds visit the undisturbed core of El Yunque. These neotropical migrant birds are flying between their wintering grounds in Central and South America and their breeding grounds in North America.

ISSUES

The primary concern for tropical forests, including El Yunque, is how to deal with habitat loss and destruction in the past, present, and future. Worldwide, rain forests cover 6% of Earth's surface, yet contain half of all plant and

animal species. That means they contain anywhere from 2 million to 20 million species. The rain forests, and the species that live in them, are being lost very rapidly. Each hour, about 3600 hectares (9000 acres) of rain forest are cleared. At the same time, six plant or animal species go extinct.

On Puerto Rico, tropical forest once covered the island. About 85% of the forest was cleared for agriculture and urban development. Trees were sold for lumber and burned to make charcoal. Today, foresters use the Caribbean National Forest to study which trees would be good to grow and sell.

The decline of the Puerto Rican parrot and [coqui frog](#) indicate that this tropical system might be in trouble. Biologists blame habitat loss and hunting for the decline of these animals. The Puerto Rican parrot makes its nest in cavities of very large trees. With the removal of most of the rain forest, only small patches of large trees remained. El Yunque still has a large enough forest to support the large trees needed by the parrots.

As the forests become more fragmented into smaller patches, they can support smaller and smaller populations of organisms. When populations are small, the effects of hurricanes, parasitic flies, competition, and predation are more devastating.

Eighty percent of the life-forms in tropical rain forests have not been named or scientifically identified. Some live only in very small and remote areas and could be important sources of drugs or other medical uses. The fear is that species are disappearing with rain forests before they are even discovered and scientifically described.

In some underdeveloped countries, rain-forest land is cleared to provide land for grazing and agriculture. This may be the only way for a family to obtain food. Large trees are cleared and sold to lumber companies. The remaining vegetation is often burned to clear the land. The open space is then used to raise [cattle](#) or crops that are more profitable.

How tropical forests are cleared

Tropical logging has similar impacts as logging in temperate deciduous forests. Roads are made, and soil gets compacted by heavy vehicles and machinery. The roads become barriers to small organisms in the understory, and forests become fragmented. Many tropical logging efforts focus on old-growth forest, the oldest and largest trees. The larger trees are more profitable to the lumber companies because they can get larger, more expensive cuts of lumber. Old-growth forests are usually clear-cut: every tree, no matter the size, is cut.

If the land is to be used for cattle grazing or agriculture, it must first be cleared. If there is no large timber, the plants are burned where they are felled, because they aren't worth selling to timber companies. This type of forest clearing is called slash and burn. Areas cleared for logging, cattle grazing, or other reasons have a difficult time recovering in the tropics. Cleared areas are susceptible to erosion, and the shallow, nutrient-poor soil is good cropland for only a few years. Then a new area is cleared.

The small stands of tropical forest that remain are not as healthy as an intact forest. The edges of the forest receive more sun. These forest fragments are often too small to support populations of large tropical animals and birds.



Courtesy of J. M. Meyers, National Biological Service, U.S. Geological Survey

Puerto Rican parrots

El Yunque as an example of past forest destruction

Clearing a tropical forest impacts the plants and animals that live there. The Puerto Rican parrot, which lives in the El Yunque Caribbean National Forest, is an excellent example. At the time of Spanish conquest, tropical forest covered much of Puerto Rico. The parrots lived in all habitats on the island and surrounding islands. The population is estimated to have been 100,000–1,000,000 birds.

In the late 1800s and early 1900s, agriculture and urban development destroyed 90% of the forested land on the island. This habitat destruction, along with hunting, contributed to the decline of the Puerto Rican parrot. In 1937 the parrot population was estimated to be about 2000 birds. The birds were found only in the forests of the Sierra de Luquillo. In the late 1940s hunting Puerto Rican parrots was banned.

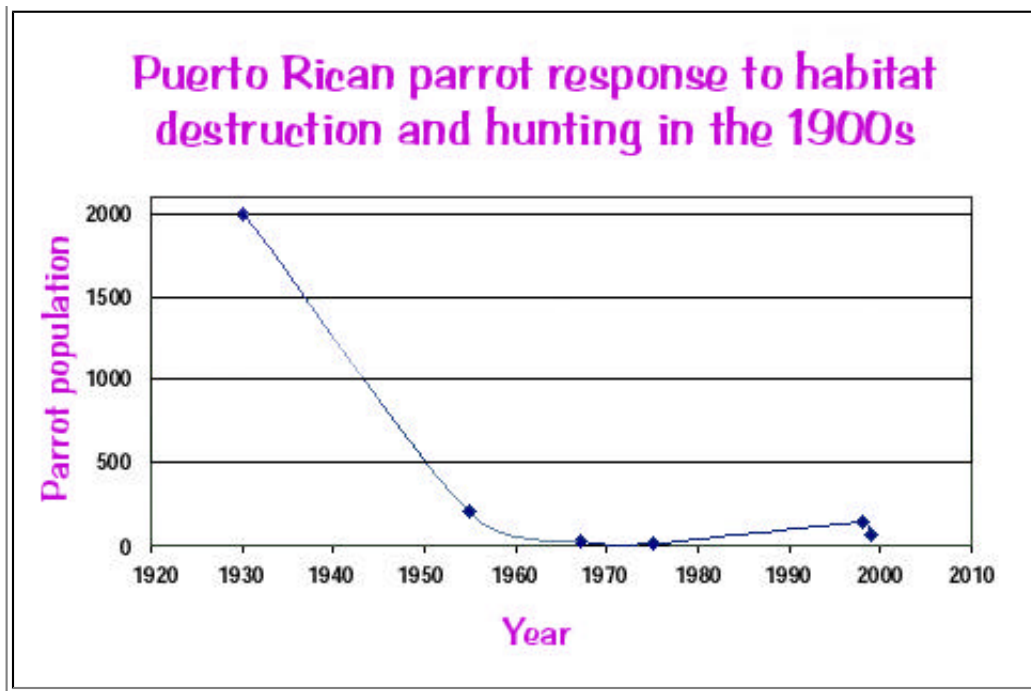


Courtesy of Father Alejandro Sánchez

As the human population in Puerto Rico grows, large sections of the forest are cut to make way for residential development, such as this one near Caguas.

The Puerto Rican Parrot Recovery Program started in 1968. This program is run by the U.S. Forest Service, the Puerto Rican Department of Natural Resources, the U.S. Fish and Wildlife Service, and the World Wildlife Federation. The program is trying to increase the parrot population so it will no longer be in danger of extinction. In the 1970s the population reached a low of only 14 parrots. Nest sites of the parrot are guarded, monitored, and maintained. By 1989 the population had increased to 47.

Before Hurricane Georges in 1998, over 140 Puerto Rican parrots existed, two-thirds in captivity. After the hurricane only 6 breeding pairs remained. There are currently about 25–26 parrots in the forest and 56 in captivity. On June 27, 2000, 10 Puerto Rican parrots were released, and on June 2, 2001, another 16 were released into the wild from the captive breeding program.



While the number of Puerto Rican parrots is slowly increasing, El Yunque is faced with the disappearance of another of its unique species. The [coqui frog](#) is a small tropical tree frog and a favorite tropical forest animal of Puerto Ricans. It is known for its singing chirps of "ko-kee...ko-kee..." Several species are now considered extinct, and others are found only in specific sites within the forest. Will further destruction of the forest signal the end of this frog?



The issues of habitat loss, rain-forest destruction, and extinction of species is not unique to El Yunque Caribbean National Forest. Rain forests throughout the world face the same stresses and pressures. Because of the wide diversity of species of organisms found in the rain forest, the plants and animals that are threatened are unique to each tropical forest.

THE DEBATE

Before making decisions that affect an ecosystem, it is important to gather information from a variety of sources. Below are the views of several individuals or groups that have an interest in the future of the El Yunque Caribbean National Forest. After each quote the hyperlink goes to the original source of the quote. Refer to these sites for more information.

Use the information provided to decide where you stand on this debate.

DEBATE: Should rain forests be cleared for logging, cattle grazing, and other development?

People who support clearing more rain forest for development

Cattle rancher in Costa Rica

"It is possible to raise cattle on rain-forest land with more scientific ranching methods. The government is helping farmers use their land more efficiently. This will mean that less rain forest will be cut down in the future."

PBS and Turner Adventure Learning, Science in the Rainforest: Some Costa Rican Ranchers Are Thinking Green

"By using modern management methods, genetically improved herds, better veterinary care, and feedlots, Costa Rican ranchers could produce the same amount of beef on a fraction of the land, Amador says. 'In Costa Rica, the days of burning down rainforest to create cattle pasture are over,' he says."

http://www.pbs.org/tal/costa_rica/treepast.html

Resident of Hawaii

"I don't see the need to worry about losing the coqui frogs in Puerto Rico. They have become a pest here in Hawaii. And I understand they have been introduced to several other Caribbean islands and are doing just fine."

Hawaii Ecosystems at Risk, Alien Caribbean Frogs in Hawaii

"Non-native Caribbean frogs (*Eleutherodactylus* spp.; not true 'tree frogs', as some have called them) have become established in small areas in Hawaii. They cause both environmental and 'people' problems. These creatures may have a special appeal to some people; and, as many people know, frogs and other amphibians are having problems on a global scale. However, these frogs do not belong in Hawaii: their existence here causes serious problems to Hawaii's special native flora and fauna, and the extremely loud noise they make may cause sleepless nights for Hawaii residents and visitors."

<http://www.hear.org/AlienSpeciesInHawaii/species/frogs/index.html>

T. S. Campbell, The Puerto Rican Coqui, Eleutherodactylus coqui; Institute for Biological Invasions Invader of the Month

"This small amphibian affects humans in their pursuit of happiness, and their loud call is the main reason they are considered pests. In the U.S. Virgin Islands, the exotic but familiar coqui is just one more in a large suite of vociferous anurans."

<http://invasions.bio.utk.edu/invaders/coqui.html>

Kayu International Teak, Forest Management/Environment

"Logging inevitably affects the environment. But with careful planning and sound operational practices, disturbances to the forest can be minimized. [With] continuously improved felling techniques, improved overall forest management, innovative harvesting methods, downstream processing coupled with commitment from timber producing countries, sustainable logging can be achieved."

<http://www.kayu.com/tropicalrainforests/>

People who support preserving the world's rain forests

Medical researcher

"Many of the medicines we use today were derived from rain forest plants. There is no way to estimate how many there are out there that we haven't yet discovered."

Raintree Nutrition, Rainforest Facts

"Rainforests currently provide sources providing one-fourth of today's medicines, and 70% of the plants found to have anti-cancer properties are found only in the rainforest. The rainforest and its immense undiscovered biodiversity holds the key to unlocking tomorrow's cures for devastating diseases. How many cures to devastating disease have we already lost?"

<http://rain-tree.com/facts.htm>

Resident near El Yunque

"We love to hear the sounds of the coqui frogs at night. We used to hear them all over Puerto Rico; now they are only at El Yunque."

U.S. Fish and Wildlife Service, Division of Endangered Species, Species Accounts: Golden Coqui (Eleutherodactylus jasperi)

"The coqui's threatened status is based on the past and potential loss of habitat to development for homes, agriculture and other purposes; on the potential for overcollecting; and on the fact that the species has a specialized, obligate bromeliad-dwelling mode of existence coupled with a low reproductive rate, inability to disperse, and a limited range, thus making its existence naturally precarious. Recent studies indicate that acid rain may play a role in the decline of this and other species of *Eleutherodactylus* in Puerto Rico."

<http://endangered.fws.gov/i/d/sad0e.html>

Nick Brokaw, Luquillo Experimental Forest, Long-Term Ecological Research Project, Disturbance and Recovery

"Disturbance and recovery are major drivers of ecosystem structure and function in the Luquillo Experimental Forest (LEF). Two striking features of disturbance in the LEF are the long history of natural hurricane disturbance and the recent history of drastic human disturbance. Other natural disturbances include landslides, treefalls, floods, and droughts. Human disturbances include clearing for pasture and crops, creation of coffee plantations, logging, road construction, and withdrawal of water from streams. The frequency and variety of this disturbance regime creates a landscape of patches differing according to how and when they were last disturbed. An important overall finding is that the forest recovers fairly quickly after natural disturbance, since local species are adapted to these natural events. By contrast, the impacts of human disturbance, which are novel and drastic events in evolutionary history, last longer."

http://luq.lternet.edu/research/projects/disturbance_and_recovery_description.html

Tropical Rainforests, Saving What Remains

"There are numerous forest products that can be collected in a renewable fashion on a small scale by local peoples. Although peasant farmers must still overcome their ignorance of sustainable forest products and overcome the difficulties of distribution, the harvesting of forest products without destroying the forest can be more profitable than the other alternative."

<http://www.mongabay.com/1003.htm>

Rainforest Action Network, Rainforests and Global Warming: Rainforest Fact Sheets

"Clearing and burning rainforests release vast amounts of greenhouse gases such as carbon dioxide, methane, ozone, and nitrous oxide into the atmosphere. Each year deforestation contributes 23–30 percent of all carbon dioxide in the atmosphere...The destruction of the Earth's rainforests not only contributes to global warming, but, as noted, also undermines the long-term ability of the Earth's atmosphere to neutralize greenhouse gases...This diminishes the Earth's ability to stabilize the atmosphere."

http://www.ran.org/info_center/factsheets/04a.html

Questions

- Which side of of this debate do you support?
- What scientific evidence supports your position?
- After looking at the evidence, did you change your position? Please explain why.

WEB LINKS

U.S. Department of Agriculture, Forest Service, Caribbean National Forest - <http://www.southernregion.fs.fed.us/caribbean/>

El Boricua un Poquito de Todo...a monthly bilingual, cultural publication for Puerto Ricans - <http://www.elboricua.com/coqui.html>

Exploratorium, *Sounds of the Rainforest* - <http://www.exploratorium.net/frogs/rainforest/index.html>

Father Sánchez's website of West Indian natural history - <http://www.kingsnake.com/westindian/>

Hawaii Ecosystems at Risk, U.S. Geological Survey, *Alien Caribbean Frogs in Hawaii* - <http://www.hear.org/AlienSpeciesInHawaii/species/frogs/index.html>

Hecho en Puerto Rico, *El Yunque* - <http://www.hechoenpuertorico.org/yunque/>

International Institute of Tropical Forestry (IITF), U.S. Department of Agriculture Forest Service - <http://luq.lternet.edu/iitf/index.html>

J. Michael Meyers, U.S. Department of the Interior, National Biological Service, *Puerto Rican Parrots* - <http://biology.usgs.gov/s+t/noframe/b016.htm>

Kayu International Teak, *Forest Management/Environment* - <http://www.kayu.com/tropicalrainforests/>

Luquillo Experimental Forest, Long-term Ecological Research Project - <http://luq.lternet.edu/>

Nick Brokaw, Luquillo Experimental Forest, Long-Term Ecological Research Project, *Disturbance and Recovery* - http://luq.lternet.edu/research/projects/disturbance_and_recovery_description.html

Pajaro Jai Foundation, *Rain Forest Furniture* - http://www.jabinc.org/PJF/pjf_furnitur.htm

PBS and Turner Adventure Learning, *Science in the Rainforest, Some Costa Rican Ranchers Are Thinking Green* - http://www.pbs.org/tal/costa_rica/treepast.html

Rainforest Action Network, *fact sheets* - http://www.ran.org/info_center/factsheets/

Rainforest Action Network, *Rainforests and Global Warming: Rainforest Fact Sheets* - http://www.ran.org/info_center/factsheets/04a.html

Rainforest Alliance, *Rainforest Resources/Facts* - <http://www.rainforest-alliance.org/resources/index.html>

Rainforest Alliance, *Sustainable Agriculture* - <http://www.rainforest-alliance.org/programs/cap/>

Raintree Nutrition, *Rainforest Facts* - <http://rain-tree.com/facts.htm>

Smithsonian Tropical Research Institute, *Rainforests* - <http://www.stri.org/Rainforest/>

Tropical Rainforests - <http://www.mongabay.com/home.htm>

Tropical Rainforests, *Saving What Remains* - <http://www.mongabay.com/1003.htm>

T. S. Campbell, *The Puerto Rican Coqui, Eleutherodactylus coqui*. Institute for Biological Invasions Invader of the Month - <http://invasions.bio.utk.edu/invaders/coqui.html#Impacts>

U.S. Fish and Wildlife Service, Division of Endangered Species, *Species Accounts: Golden Coqui (Eleutherodactylus jasper)* - <http://endangered.fws.gov/i/d/sad0e.html>

World Rainforest Information Portal, *Cattle Ranching* - http://www.rainforestweb.org/Rainforest_Destruction/Cattle_Ranching/?state=more
